Metric Analyses of an Early Holocene Human Skeleton From Gua Gunung Runtuh, Malaysia

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ABSTRACT A nearly complete human skeleton dating to the Early Holocene (epi-Paleolithic culture) excavated from Gua Gunung Runtuh, Malaysia, is described. Cranial, dental, and limb bone measurements are recorded on the skeleton, and compared with early and modern skeletal samples from Southeast Asia and Australia. The comparisons demonstrate that the Gua Gunung specimen is most similar to Australian Aborigines in dental and limb measurements, while the cranial measurements indicate a close affinity to Mesolithic samples from Malaysia and Flores. These findings further suggest that the Gua Gunung skeleton, as well as other fossils from Tabon and Niah, are representative of an early group of people who occupied Sundaland during the late Pleistocene, and may be the ancestors of Australian Aborigines. Some of the dental and limb bone measurements exhibited by the ancestors persist in Southeast Asian populations until the early Holocene. Differences in cranial traits have, however, accumulated since the late Pleistocene in Australian Aborigines and early Southeast Asian peoples. Am J Phys Anthropol 109:327–340, 1999.

An almost complete human skeleton was discovered during excavations undertaken in the 1990s by Professor Zuraina Majid of Universiti Sains Malaysia, at Gua Gunung Runtuh. The site is located in a cave in the Bukit Kepala Gajah limestone massif in the Lenggong Valley of the Malaysian State of Perak. The skeleton, a primary burial, was associated with mortuary objects of the Palaeolithic tradition. A radiocarbon date of 10,120 ±110 BP (Beta 38394) indicates that the burial is from the early Holocene. The term "epi-Palaeolithic" refers to the Gua Gunung culture (Zuraina, 1994). The skeleton from Gua Gunung is, thus far, the most complete specimen from Southeast Asia found for the time period 10,000–11,000 years BP.

Human skeletal remains, from the preceramic levels associated with tools similar to those found with the Gua Gunung specimen, have been excavated from other cave sites in the State of Perak, Malaysia. In Gua Kajang, a cave also located in the Lenggong District, Evans (1918) reported finding a fragment of a jaw with some teeth, probably that of a female. Further, Evans, Gordon, and Callenfels collected several fragments of human bones from Gua Kerbau in Gunong Pondok (Callenfels, 1936). Duckworth (1934), in his examination of these specimens, noted affinities to Australo-Melane-

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sians. From Gua Kepah, a shell midden site in mainland Penang, Mijsberg (1940) unearthed human jaws, which he characterized as Paleo-Melanesian. Early studies frequently described the morphological features of these specimens as typical of Australo-Melanesians, citing their dolichocranic skulls, massive jaws with relatively large teeth, alveolar prognathism, and long slender limbs. As will be seen, the Gua Gunung skeleton shares similar characteristics with these earlier described specimens.

In an attempt to evaluate the affinities of the Gua Gunung skeletal remains, a statistical comparison of the skeletal and dental measurements was undertaken. A preliminary analysis of the tooth crown measurements recorded in the Gua Gunung specimen indicated a close affinity with early and modern Australians (Matsumura and Zuraina, 1995). This latter finding suggests that populations similar to indigenous Australians existed in this region during the Early Holocene.

In the present study, we report on the cranial and limb bone measurements recorded in the cleaned and reconstructed Gua Gunung remains. The condition of these remains is now much better than when Jacob and Soepriyo (1994) conducted their study. We also report the results of statistical comparisons with early and modern samples from Australia and Southeast Asia, including further comparisons of dental measurements.

MATERIALS AND METHODS

The Gua Gunung skeleton (Fig. 1) is kept at the Center for Archaeological Research Malaysia in the Universiti Sains, Penang, Malaysia. The initial reports on the condition, preservation, and morphological description of these remains were made by Jacob and Soepriyo (1994), Loh (1994), and Jamaludin (1994). Using features of the os coxae, the sex of this individual was determined to be male.

The skeletal measurements were taken following Martin and Saller (1957). The dental crown measurements were made according to the method of Fujita (1949). As shown in Table 1, the measurements recorded in the Gua Gunung crania are restricted to the posterior portions of the cranium and some parts of the maxillary and zygomatic bones. Only the buccolingual diameters, also given in Table 1, were recorded in the Gua Gunung dentition because the mesiodistal dimensions were affected by heavy attrition. The long limb bone measurements are reported in Table 2.

In order to compare the Gua Gunung skeleton with other specimens, the first author measured crania and dentitions, designated "Mesolithic," from Flores and Malaysia. These latter specimens, ranging in date from ca. 7,000 BP to ca. 4,000 BP, are from the Liang Momer, Liang X, Gua Alo, and Gua Nempong sites in Flores (described by Jacob, 1967), the Gua Cha site in Kelantan, and the Gua Kepah site in mainland Penang, Malaysia. Additional dental data were recorded in modern skeletal samples from Java, Celebes, Timor, Sumatra, Banca, and Mentawai Islands. These early and modern Southeast Asian series are stored at the Nationaal Natuurhistorisch Museum in Leiden, the Natural History Museum in London, and in the University of Cambridge (Duckworth Collection). Additional published data on cranial, dental, and limb measurements of prehistoric and modern Australians and Southeast Asians were also used in the present comparisons. Other comparative data representing late Pleistocene specimens included Minatogawa from Okinawa Island, Japan; Liujiang from southern China; Keilor and Coobool Creek from Australia; and Wadjak from Java. The locations of comparative samples are presented in Figure 2.

The comparative craniometric data and their sources are given in Table 3. Only seven male measurement items, which were common to the Gua Gunung and all published cranial metric data, were used in these statistical comparisons. Table 4 gives the buccolingual crown diameters for the 14 comparative male samples, including sample sizes and data sources. The buccolingual crown diameters were from nine teeth, including the maxillary second premolar, first and second molars, and all the mandibular teeth except for the first and third molars.

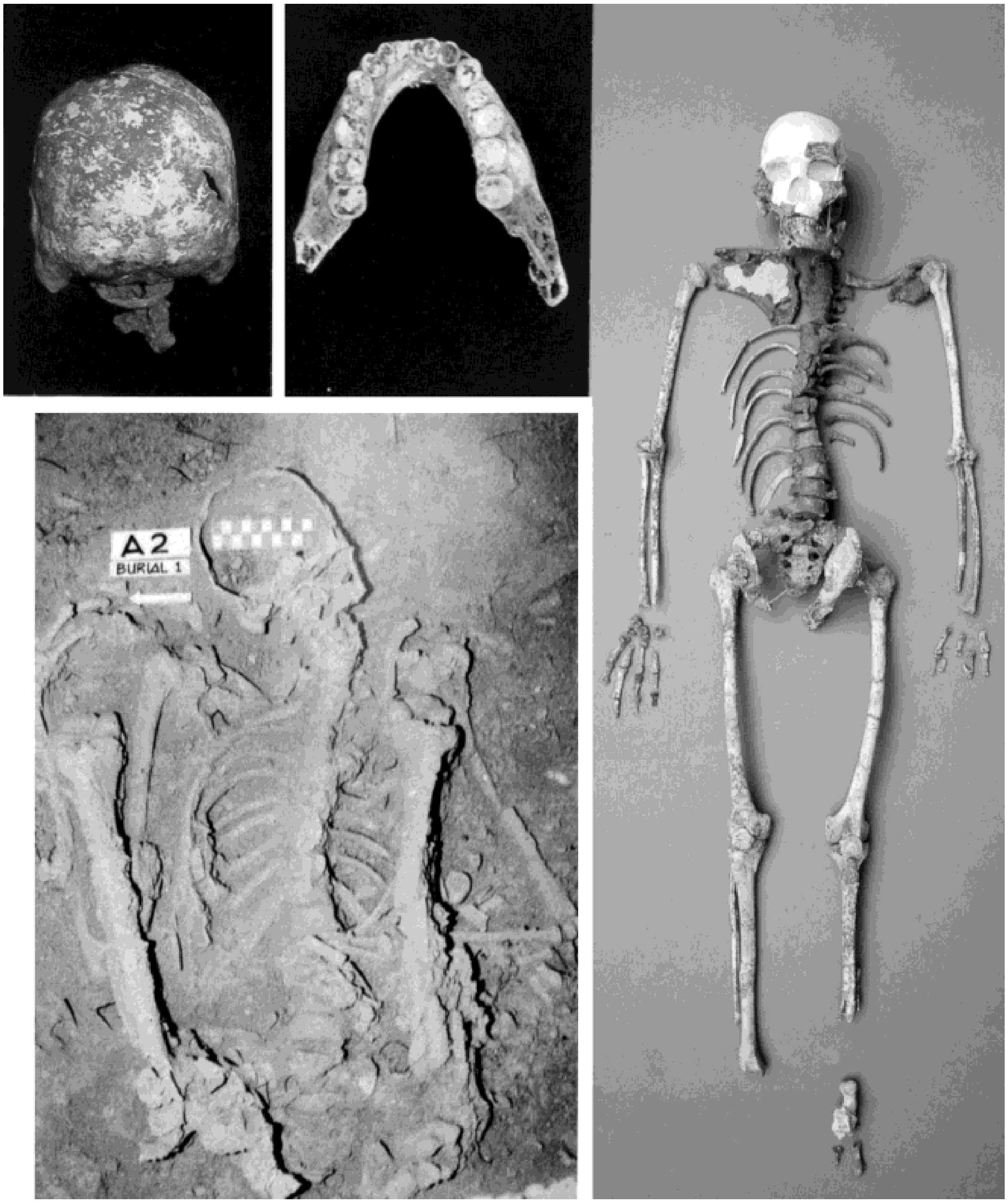

Fig. 1. Gua Gunung skeleton from the State of Perak in Malaysia **Upper left:** Posterior view of the cranium. **Upper center:** Mandible **Lower left:** Burial as seen at excavation **Right:** Skeleton reconstructed in extended position.

Long limb bone measurements and indices for eight male samples used in these comparisons are presented in Table 5. Given the limitations of the Gua Gunung specimen, these latter comparisons were limited to 10 measurements. The measurements for the Gua Gunung specimen were from the right side.

TABLE 1. Cranial, mandibular, and dental measurements (mm) of the Gua Gunung skeleton[1]

Martin no. and measurement		Martin no. and measurement		Buccolingual crown diameter	
7. Foramen magnum length	35	61. Alveolar breadth	58	Maxillary dentition	
8. Maximum cranial breadth	136	61 (2). Bicanine breadth	48	Second premolar (P2)	10.00 (R)
11. Biauricular breadth	126	63. Internal palate breadth	38	First molar (M1)	12.31 (R)
12. Biasterionic breadth	110	64. Palatal height	16	Second molar (M2)	12.95 (R)
13. Bimastoid breadth	105	66. Bigonial breadth	92	Mandibular dentition	
16. Foramen magnum breadth	29	67. Bimental breadth	48	Central incisor (I1)	6.03 (L)
28. Occipital arc	116	68. Mandibular length	84	Lateral incisor (I2)	6.96 (L)
28 (2). Inion-opisthion arc	45	69. Symphysel height	34	Canine (C)	8.72 (L)
30 (3). Lambda-asterion chord	83	69 (1). Mandibular height at mental	31	First premolar (P1)	9.35 (L)
31. Occipital chord	102			Second premolar (P2)	9.94 (L)
31 (1). Lambda-inion chord	69	69 (2). Mandibular height at M2	32	Second molar (M2)	11.61 (L)
31 (2). Inion-opisthion chord	43	69 (3). Mandibular body breadth	14		
48 (d). Cheek height	24	71. Ramus breadth	39		
54. Nasal breadth	28	79. Mandibular angle	100		

[1] R, right-side tooth; L, left-side tooth.

A number of statistical analyses were performed to examine the biological affinities of the Gua Gunung specimen using these comparative samples. Q-mode correlation coefficients were calculated to evaluate similarities of proportion in the skeletal and dental measurements. Seven cranial measurements, nine buccolingual crown diameters, and 10 limb measurements, respectively were employed in deriving the Q-mode correlations. The calculated coefficients (r) were converted into a distance matrix (1-r), and a cluster analysis, using the unweighted pair-group method using arithmetic averages (Sneath and Sokal, 1973), was applied to this matrix for visual representation of the relationships between samples. As an additional way to portray relationships, plots of standardized cranial and dental measurements were constructed.

RESULTS

Analyses of cranial metrics

Q-mode correlation coefficients between samples were calculated using seven cranial measurements. The results are presented in Table 6 as a distance matrix transformed from the correlation coefficients. The sample closest to the Gua Gunung specimen is Mesolithic Gua Cha (no. H12) from Malaysia. The next closest series is Mesolithic Liang Momer E from Flores. Two modern Southeast Asian series, Atayal and Filipinos, are also close to the Gua Gunung specimen. The Minatogawa cranium is the most distant sample from the Gua Gunung specimen.

Figure 3 is a dendrogram that results from a cluster analysis of the distance matrix shown in Table 6. The close similarity of the Gua Gunung specimen with the Gua Cha H12 and Liang Momer E samples is repeated in this dendrogram. Other early and modern Southeast Asians, Australian Aborigines, and Tasmanians secondarily cluster with these samples. The Keilor and Minatogawa samples form a separate major cluster.

Based on the deviation patterns of the seven cranial measurements shown in Figure 4, the Australian, Gua Cha, and Minatogawa samples are compared with the Gua Gunung specimen. In order to standardize the measurements, data from the modern Japanese (Howells, 1989) were used. The close resemblance between the Gua Gunung and the Gua Cha samples is confirmed in this diagram. These latter two cranial samples were characterized as possessing wide nasal breadths and narrow alveolar breadths. Except for narrow alveolar breadth, Australian Aborigines resemble the Gua Cha sample in the deviation plots. The Minatogawa specimen does not exhibit any close similarities with any of these three samples.

Analyses of dental metrics

Figure 5 compares the nine buccolingual crown diameters recorded in the Gua

TABLE 2. Limb bone measurements (mm) of the Gua Gunung skeleton

Martin no. and measurement	Right	Left
Humerus		
1. Maximum length	323	325
2. Total length	318	321
3. Epiphysis width		43
4. Biepicondylar width	53	51
5. Maximum diameter of mid-shaft	20	18
6. Minimum diameter of mid-shaft	15	14
6a. Minimum diameter of shaft at deltoid tuber	17	16
6b. Transverse diameter of mid-shaft	19	17
6c. Sagittal diameter of mid-shaft	17	16
7a. Circumference of mid-shaft	60	52
7. Least circumference of shaft	55	48
8. Circumference of head		127
9. Transverse diameter of head		39
10. Sagittal diameter of head		41
11. Width of trochlea	19	17
12. Capitulum width	17	17
12a. Width of trochlea and capitulum	41	38
13. Dorso-volar diameter of trochlea	24	23
14. Width of olecranon fossa	27	27
15. Depth of olecranon fossa	10	10
16. Angle between condyle and shaft	82	84
17. Angle between head and shaft	136	133
Ulna		
1. Maximum length	285	265
2. Physiological length	250	230
3. Least circumference of shaft	34	31
4. Index of curvature of shaft	2	4
5. Height of olecranon cap	5	8
6. Olecranon width	23	22
7. Dorso-volar diameter of olecranon	22	22
8. Olecranon height	20	19
9. Anterior width of radial articular surface	8	7
10. Posterior width of radial articular sur	10	10
11. Dorso-volar diameter of shaft	15	13
12. Transverse diameter of shaft	14	12
13. Upper transverse diameter of shaft	18	15
14. Upper dorso-volar diameter of shaft	20	17
15. Ulnar angle	87	79
Radius		
1. Maximum length	277	241
2. Physiological length	270	233
3. Least circumference of shaft	34	31
4. Transverse diameter of shaft	13	12
5. Dorso-volar diameter of shaft	12	10
4a. Transverse diameter of mid-shaft	12	10
5a. Dorso-volar diameter of mid-shaft	12	11
5 (4). Circumference of neck	38	38
5 (6). Width of lower epiphysis		24
6. Index of curvature of shaft	2	11
7. Angle between neck and shaft	7	7
Femur		
1. Maximum length	454	449
2. Physiological length	451	446
3. Trochanter-condyle maximum length	432	437
4. Trochanter-condyle physiol. length	429	435
5. Shaft length	374	379
6. Sagittal diameter of mid-shaft	32	34
7. Transverse diameter of mid-shaft	21	22
8. Circumference of mid-shaft	84	88
9. Subtrochanteric transverse diameter of shaft	28	26
10. Subtroch. sagittal diameter of shaft	22	
11. Supracondylar sagittal diameter of shaft	27	27
12. Supracondylar transverse diameter of shaft	32	30
13. Upper width	88	91
14. Anterior length of neck and head	64	65
15. Vertical diameter of neck	24	27
16. Sagittal diameter of neck	24	26
17. Circumference of neck	83	88
18. Vertical diameter of head	41	41
19. Transverse diameter of head	41	41
20. Circumference of head		132
21. Biepicondylar width	69	69
22. Thickness of lateral condyle	61	60
23. Maximum length of lateral condyle	61	60
24. Maximum length of medial condyle	60	59
25. Posterior height of lateral condyle	35	35
26. Posterior height of medial condyle	36	39
27. Curvature index of shaft	10	18
28. Torsion angle	24	
29. Neck-shaft angle	138	136
30. Condyle-shaft angle	197	195
Tibia		
1. Total length	391	
1a. Maximum length	395	
2. Interarticular length	378	
3. Width of upper epiphysis		68
8. Sagittal diameter of mid-shaft	27	28
9. Transverse diameter of mid-shaft	20	21
8a. Sagittal diameter at nutrient foramen	32	32
9a. Transverse diameter at nutrient foramen	20	20
10. Circumference of mid-shaft	74	76
10a. Circumference of shaft at nutrient foramen	82	84
10b. Minimum circumference of shaft	65	
11. Curvature index of shaft	2	2
12. Retroversion angle		101
Fibula		
1. Maximum length		
2. Maximum diameter of mid-shaft	12	
3. Minimum diameter of mid-shaft	10	
4. Circumference of midshaft	39	
5. Upper circumference of shaft	289	

Fig. 2. Approximate location of the Gua Gunung remains and comparative samples.

Gunung dentition with 14 comparative samples. The overall tooth sizes for the three Australian samples are remarkably larger than those of Neolithic and modern Southeast Asians, Neolithic southern Chinese, and Neolithic Jomon Japanese. Among the Australian samples compared, those from the Late Pleistocene Coobool Creek series possess the largest tooth sizes. The overall size of the Gua Gunung dentition is smaller than that of the Coobool Creek sample, but comparable to the other Australian series, Wadjak II, and the Mesolithic Malaysia and Flores samples.

Table 7 presents a distance matrix transformed from the Q-mode correlation coefficients which were computed using the nine buccolingual diameters. Of the 15 samples, the Gua Gunung specimen shows the smallest distance to the Late Pleistocene Coobool Creek Australians, followed by the two modern Australian samples and the Andamanese. The Gua Gunung specimen is most distant from any of the early or modern Southeast Asian samples, including the Wadjak II specimen.

Figure 6 is the dendrogram which results from a cluster analysis of the distance matrix in Table 7. The Australian samples form a cluster distinct from clusters containing the early and modern Southeast Asians and all other samples. The Gua Gunung specimen forms a loose connection to the Australian cluster.

Using the means and standard deviations of the modern Japanese (Matsumura, 1994) as a basis for comparison, deviation plots of nine buccolingual crown diameters for the Gua Gunung specimen, Neolithic Jomon, Swanport Aborigines, Coobool Creek, and Gua Cha samples are presented in Figure 7. Although the proportions of maxillary teeth are slightly different, Coobool Creek, Swanport, and Gua Gunung resemble each other in this diagram. The Jomon and Gua Cha series display a different pattern.

Analyses of limb bone metrics

Using Pearson's formula ($81.306 + 1.880 \times$ femoral length) based on the maximum length (45.4 cm) of the right femur (Pearson, 1899), the stature of the Gua Gunung individual is estimated to be 166.6 cm. Evidence of disease in the left arm (Jacob and Soepriyo, 1994) and curvature of the spine, however, suggests that, in life, this individual's stature was less than this estimated height.

The radio-humeral (brachial) and tibiofemoral (crural) indices (Fig. 8) indicate that forearms and lower leg lengths of the Jomon, Dayak, and Australian samples are proportionally longer than those of the Formosan, Japanese, and Minatogawa samples. The distal arm and leg limb bones of the Gua Gunung skeleton are extraordinarily long.

The pilastric index (Table 5) in the Australian Aborigines and Neolithic Jomon femora is high. The pilastric index in the Gua Gunung femora (right, 152.4) is higher than that reported for the Australian and Jomon samples. All specimens display well-developed linea asperae on the dorsal surfaces of the femoral shafts.

Q-mode correlation coefficients using the 10 limb bone measurements are given in Table 8. The Negrito and Liang Momer-E samples were excluded from this computation because of missing data. These dis-

TABLE 3. Seven cranial measurements (mm) for 11 comparative samples[1]

Martin no.	8	11	12	31	54	61	48 (d)	
Sample	Cranial breadth	Biauric. breadth	Biaster. breadth	Occipital chord	Nasal breadth	Alveolar breadth	Cheek height	Data source
Australian Aborigines	131.94	120.13	109.75	92.12	27.88	66.88	21.19	Howells, 1989
Tasmanians	138.40	123.56	109.27	93.18	28.87	67.09	21.29	Howells, 1989
Andamanese	135.66	113.34	100.26	91.69	24.71	60.80	20.23	Howells, 1989
Atayal	135.76	122.97	108.41	93.31	26.59	63.76	21.31	Howells, 1989
Filipinos	139.80	122.96	107.32	96.92	28.26	64.86	23	Howells, 1989
Mesolithic Gua Cha H12	137	127	116	102	31	64	22	Present study
Mesolithic Liang Momer E	131	119	107	99	25	63	22	Present study
L-Pleistocene? Wadjak I	151	138	114	96	30.7	71	24.8	Storm, 1995
L-Pleistocene Minatogawa I	148	128	115	98	26	70	19[2]	Suzuki, 1982
L-Pleistocene Liujiang	142.2	119[2]	108[2]	91.5	26.8	65[2]	23[2]	Woo, 1959
L-Pleistocene Keilor	142	133	111	106	27	71	23[2]	Brown, 1989

[1] L, Late.
[2] Data taken from casts.

TABLE 4. Nine buccolingual tooth crown diameters (mm) of 14 comparative samples

	Sample size	Maxillary dentition			Mandibular dentition					
		P2	M1	M2	I1	I2	C	P1	P2	M2
Swanport Aborigines[1]	13	10.4	12.9	13.5	6.7	6.7	8.8	9.7	9.2	12
Australian Aborigines[2]	18	9.99	12.64	12.81	6.31	6.43	8.32	8.73	9.03	11.41
Andamanese	25	9.58	12.13	11.95	5.92	6.25	7.64	8.21	8.72	10.51
Borneans	40	9.60	11.93	11.88	6.09	6.42	7.91	8.12	8.39	10.46
Java, Celebes, and Timor Islanders	11	9.40	12.00	11.79	5.94	6.35	8.03	8.14	8.40	10.22
Sumatra, Banca, and Mentawai Islanders	14	9.51	11.98	11.76	5.77	6.28	7.87	8.18	8.55	10.36
Neol. Southern Chinese[2]	25	9.55	12.00	11.76	6.06	6.49	7.94	8.21	8.54	10.42
Neolithic Jomon[2]	242	9.00	11.78	11.45	5.93	6.20	7.44	7.79	8.33	10.47
Neolithic Ban Kao[2]	25	9.28	12.04	11.56	5.79	6.18	7.73	8.11	8.47	10.52
Mesolithic Gua Kepah	7	9.86	12.77	12.93	6.82	7.32	8.75	9.15	9.43	11.25
Mesolithic Flores	4	10.37	12.74	12.49	6.41	6.77	8.69	8.70	9.32	10.79
Mesolithic Gua Cha	6	10.13	12.23	12.45	6.49	6.66	8.29	8.68	8.84	10.81
Late Pleistocene Wadjak II[3]	1	10.8	13.1	13.3	7.2	7.4	9.5	8.8	8.4	11.1
Late Pleistocene Coobool Creek[2]	16	10.8	13.6	13.9	7	7	9.1	9.7	9.9	12.4

[1] Brown, 1989.
[2] Matsumura, 1994, 1995a, b.
[3] Storm, 1995.

tances reflect the differences of overall limb proportion and robustness, as well as the development of the femoral pilastric structure. The distances place the Gua Gunung specimen closest to Australian Aborigines. Figure 9 is the dendrogram which results from a cluster analysis of the distances in Table 8. The Gua Gunung skeleton groups with Australian Aborigines, to which the Neolithic Ban Kao sample from Thailand is attracted. The Minatogawa, Jomon, Dayak, Japanese, and Formosan samples form a separate cluster distinct from the Gua Gunung skeleton and Australians.

DISCUSSION AND CONCLUSION

Various authors have noted similarities in the skeletal morphology of modern Australo-Melanesians and several Late Pleistocene and Early Holocene Southeast Asian human skeletal series. Brothwell (1960) concluded that the Late Pleistocene human skull (ca. 40,000? BP) from Niah Cave in Borneo was most similar to Tasmanians. The Tabon specimens (ca. 20,000 BP) from Palawan Island in the Philippine Islands have also been linked to Australians (Macintosh, 1978). Cuong (1986), in his study of two nearly complete skulls from early Hoabinhian sites in Vietnam, noted that those specimens exhibited characteristics similar to Australians as well as modern East Asians.

The general view has been that Southeast Asia was occupied by an indigenous people (sometimes referred to as the "Australo-Melanesian" lineage) prior to the expansion

TABLE 5. Limb bone measurements (mm) for nine comparative samples

Martin no. measurement[1]	Australian Aborigines	Japanese	Formosan	Dayak	Negrito	Neolithic Ban Kao	Neolithic Jomon	Liang Momer E	Minatogawa I
Humerus, (1) maximum length	326.1	294.2	313.4	303		350.7	291.5	323	287
Radius, (1) maximum length	257.4	223.0	237.7	239	214.0	249.2	235.2		215
Femur, (1) maximum length	451.4	413.7	435.7	422	380.0	458.8	418.2	443	398
Femur, (6) sagittal diameter of mid-shaft	28.1	27.2	27.0	27	25.2	26.5	29.3	28	27
Femur, (7) transverse diameter of mid-shaft	24.7	25.3	25.6	26	20.3	26.8	25.5	25	26
Femur, (9) subtrochanteric transverse diameter of shaft	29.1	29.3	29.6	30	25.6	30.5	30.5	29	29
Femur, (10) subtrochanteric sagittal diameter of shaft	23.1	25.2	23.7	22	20.3	24.8	24.2	24	23
Tibia, (1a) maximum length	384.2	331.6	355.3	354		377.0	349.5	370	322
Tibia, (8) sagittal diameter of mid-shaft	30.4	28.5	28.2	31	32.6	26.0	32.1	31	27
Tibia, (9) transverse diameter of mid-shaft	21.0	21.0	22.1	21		20.0	19.6	19	19
Radio-humeral index	78.9	75.8	75.8	78.8		71.1	80.7		74.9
Tibio-femoral index	85.1	80.2	81.5	83.9		82.2	83.6	83.5	80.9
Femur, pilastic index	113.8	107.5	105.5	103.8	124.1	98.9	114.9	112.0	103.8
Tibia, mid-shaft index	69.1	73.7	78.4	67.7		76.9	61.1	59.7	70.4
Data source	Yamaguchi, 1967	Miyamoto, 1927; Hirai and Tanabe, 1928	Koh, 1942; Hsu, 1949; Wang, 1950	Yokoo, 1931	Ganet-Vercin, 1951	Sanguvichien et al., 1969	Kiyono and Hirai, 1928	Jacob, 1967	Baba and Endo, 1982

[1] Shown in parenthesis.

TABLE 6. Distance matrix of Q-mode correlation coefficients based on seven cranial measurements

Sample	Gua Gunung	Australian Aborigines	Tasmanians	Andamanese	Atayal	Filipinos	Gua Cha	Linag Momer	Wadjak	Minatogawa	Liujiang
Australian Aborigines	0.974										
Tasmanians	0.852	0.156									
Andamanese	0.775	0.820	0.548								
Atayal	0.524	0.320	0.111	0.643							
Filipinos	0.491	0.482	0.199	0.211	0.209						
Gua Cha H12	0.312	0.348	0.338	0.818	0.215	0.388					
Liang Momer E	0.451	0.927	1.204	0.890	1.125	0.952	0.565				
Wadjak I	0.853	0.666	0.281	0.778	0.214	0.399	0.686	1.666			
Minatogawa I	1.249	0.879	0.584	0.869	0.582	0.863	0.871	1.550	0.451		
Liujiang	0.892	0.579	0.339	0.188	0.365	0.231	0.783	1.217	0.460	0.656	
Keilor	1.168	1.275	0.979	1.313	1.002	1.153	1.060	1.519	0.610	0.483	1.384

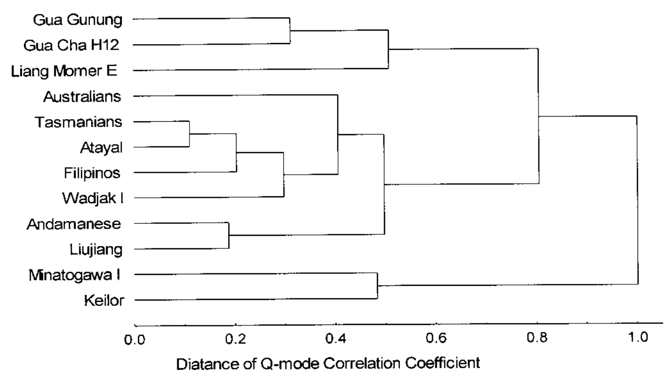

Fig. 3. Dendrogram of a cluster analysis applied to the distances of Q-mode correlation coefficients, based on seven cranial measurements.

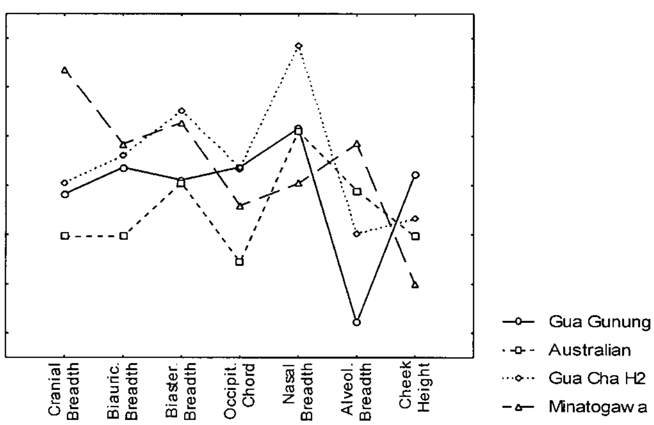

Fig. 4. Standardized deviations of seven cranial measurements, using modern Japanese as the basis of comparison.

of immigrants from northern and eastern Asia who entered this region via southern China. According to this model, the modern peoples of Southeast Asia exhibit traits that reflect this dual ancestry (Callenfels, 1936; Mijsberg, 1940; Von Koenigswald, 1952; Coon, 1962; Jacob, 1967, 1975; Bellwood, 1987).

Recent cranial and dental studies, however, suggest a different interpretation. Studies by Turner (1989, 1990, 1992) of nonmetric dental traits demonstrated that early

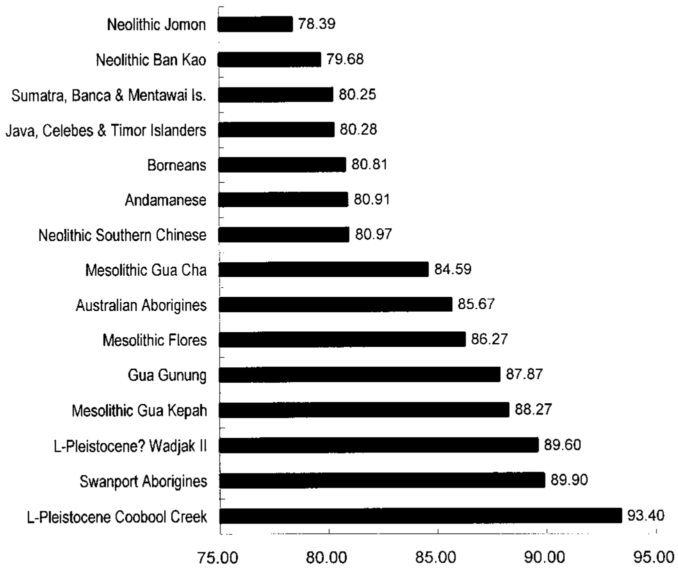

Fig. 5. Summation of the nine buccolingual crown diameters in the Gua Gunung specimen and 14 comparative samples.

and modern Southeast Asians, as well as Australian Aborigines, display the so-called "Sundadont" dental complex. These findings may indicate that Australian Aborigines and Southeast Asians originated from a common ancestral population which occupied Sundaland in Late Pleistocene times. On the other hand, cranial studies by Hanihara (1993, 1994) advanced the view that Proto-Malays, such as the present-day Dayak, were widely dispersed throughout Southeast Asia during the Late Pleistocene. The latter researcher regarded Proto-Malay as the original source for the present-day Southeast Asians as well as the Neolithic Jomon Japanese. These researchers have advanced the view that the present-day Southeast Asians evolved by local adaptation without any admixture of North/East Asians. Further, the assessment of Hanihara (1993, 1994) does not favor the view that early Southeast Asia was occupied by people possessing an Australian morphology.

Our study of the Gua Gunung specimen, while not so much concerned with the population history of present-day Southeast Asia, does suggest that early indigenous people were present in this region. The archaeological evidence for the occupation of Australia indicates that the first inhabitants reached there approximately 50,000 years ago (Bowdler, 1992). The Australian teeth, which are most like those of the early Southeast Asians (Turner, 1992; Matsumura, 1995b), suggest a Sundaland origin of the Australian Aborigines. Until the end of the last glacial stage, lowered sea level reduced the water barrier between Australia and Southeast Asia, thus permitting genetic exchange between the inhabitants of these two regions. Our study has demonstrated a close resemblance between the Gua Gunung skeleton and Australian Aborigines in dental and limb bone segment measurements, while the cranial metrics resemble other early Malay and Flores samples such as the Gua Cha and Liang Momer specimens. In our view, the Gua Gunung skeleton, as well as other fossils from Tabon, Niah, and Vietnam, were from members of a population that originated in Sundaland during Late Pleistocene times, and are likely the ancestors of modern Australian Aboriginals. Some dental traits and limb measurements have been retained in the peoples of Southeast Asia until the Early Holocene. Other traits, such as aspects of cranial shape, have changed since the Late Pleistocene.

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TABLE 7. Distance matrix of Q-mode correlation coefficients based on nine buccolingual crown diameters

Sample	Gua Gunung	Swanport Aborigines	Australian Aborigines	Andama-nese	Borneans	Java Celebes Timor	Sumatra Banca Mentawi	Neolithic Southern Chinese	Neolithic Jomon	Ban Kao	Gua Kepah	Mesolithic Flores	Gua Cha	Wadjak II
Swanport Aborigines	0.953													
Australian Aborigines	0.943	0.232												
Andama-nese	0.945	0.760	0.358											
Borneans	1.714	0.959	0.762	0.479										
Java, Celebes, and Timor Islanders	1.793	1.245	1.046	0.667	0.307									
Sumatera, Banca, and Mentawai Islanders	1.032	1.036	0.641	0.142	0.564	0.529								
Neolithic Southern Chinese	1.566	1.224	0.953	0.399	0.117	0.238	0.408							
Jomon	1.212	0.857	0.530	0.334	0.349	0.716	0.649	0.308						
Ban Kao	1.045	0.736	0.369	0.185	0.602	0.717	0.278	0.459	0.258					
Gua Kepah	1.218	1.172	1.111	0.860	0.726	0.627	1.143	0.556	0.428	0.848				
Mesolithic Flores	1.245	1.300	0.904	0.549	0.657	0.367	0.357	0.505	0.968	0.718	1.026			
Gua Cha	1.543	0.786	0.745	0.516	0.132	0.434	0.647	0.265	0.568	0.796	0.782	0.578		
Wadjak II	1.952	1.058	1.116	1.248	0.419	0.330	1.145	0.648	1.012	1.211	0.919	0.792	0.531	
L-Pleis-tocene Coobool Creek	0.880	0.209	0.029	0.440	0.903	1.086	0.732	1.047	0.611	0.412	1.052	0.887	0.819	1.171

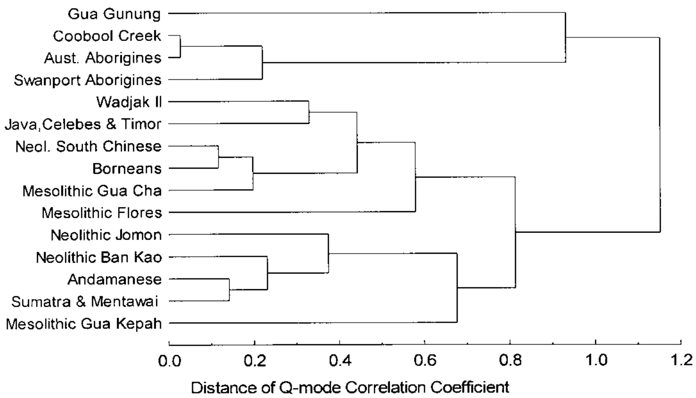

Fig. 6. Dendrogram of a cluster analysis applied to the distances of Q-mode correlation coefficients, based on nine buccolingual crown diameters.

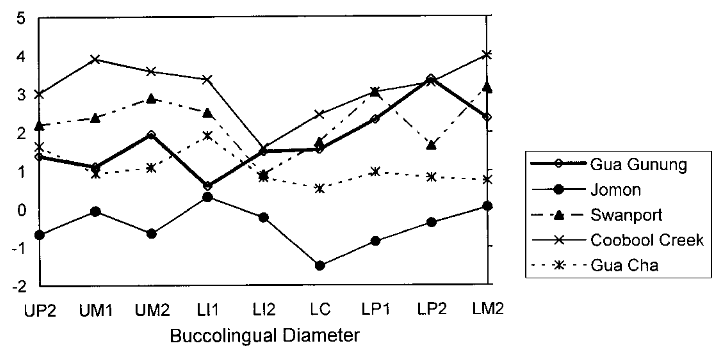

Fig. 7. Standardized deviations of nine buccolingual crown diameters, using modern Japanese as the basis of comparison.

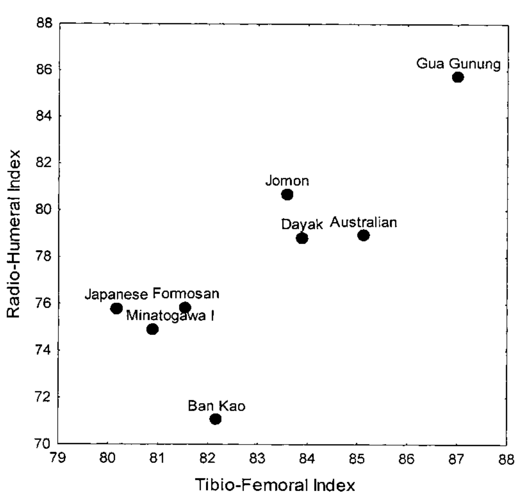

Fig. 8. Diagram of radio-humeral and tibio-femoral indicies of the Gua Gunung specimen and seven comparative samples.

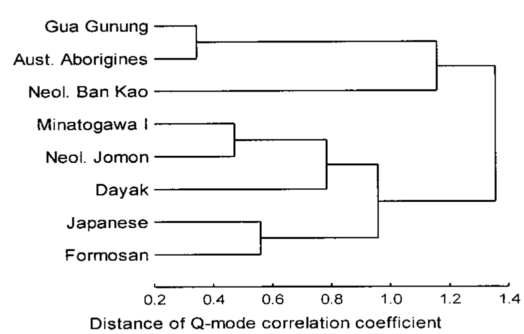

Fig. 9. Dendrogram of a cluster analysis applied to the distances of Q-mode correlation coefficients, based on 10 limb bone measurements.

TABLE 8. Distance matrix of Q-mode correlation coefficients based on 10 limb measurements

	Gua Gunung	Australian Aborigines	Japanese	Formosan	Dayak	Jomon	Ban Kao
Australian Aborigines	0.344						
Japanese	1.646	1.638					
Formosan	1.366	1.030	0.560				
Dayak	1.418	0.954	1.118	0.763			
Neolithic Jomon	1.403	1.535	0.702	1.479	0.701		
Neolithic Ban Kao	1.155	1.158	1.126	0.979	1.434	1.412	
Minatogawa I	1.703	1.786	0.527	1.156	0.867	0.471	0.904

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